Model Answer B.Sc. III semester (Forensic Sci) ①

paper Code :- AS-2776(A) (Basic Electronics)

Section-A

1. (i) (b)

(ii) (a)

(iii) (d)

(iv) (a)

(v) (b)

(vi) (b)

(vii) (b)

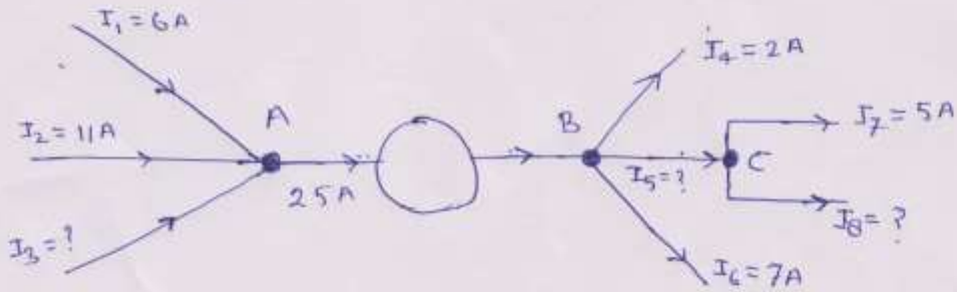
(viii) (d)

(ix) (a)

(x) (b)

Section-B

2.



By Applying Kirchhoff's Law at node A.

$I_1 + I_2 + I_3 = 25A$

$6A + 11A + I_3 = 25A$

$I_3 = 25A - 17A$

$\boxed{I_3 = 8A}$

Applying Kirchhoff's current law at Node B.

$$25\,A = I_4 + I_5 + I_6$$

$$25A = 2A + I_5 + 7A$$

$$I_5 = 25A - 9A$$

$$\boxed{I_5 = 16A}$$

Applying Kirchhoff's current law at Node C.

$$I_5 = I_7 + I_8$$

$$I_8 = I_5 - I_7$$

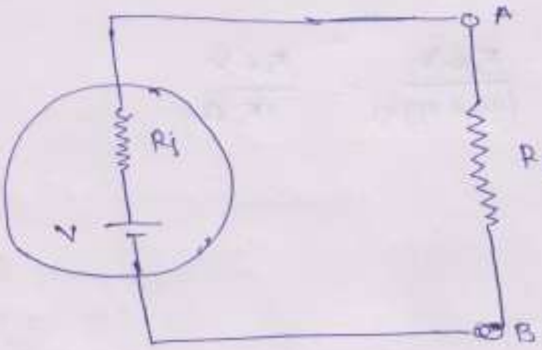
$$I_8 = 16A - 5A$$

$$\boxed{I_8 = 11A}$$

Answer- 3

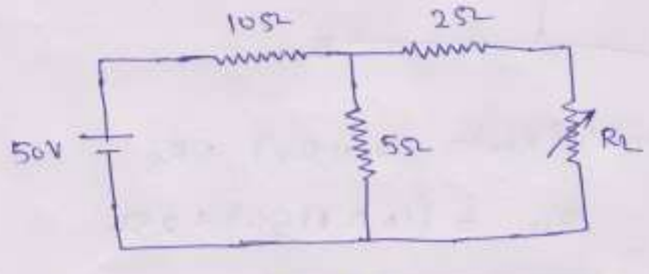
Statement of maximum power transfer:

"Maximum power is transferred from a source to load when the load resistance is made equal to the Internal resistance of the Source".



maximum power will be transferred when

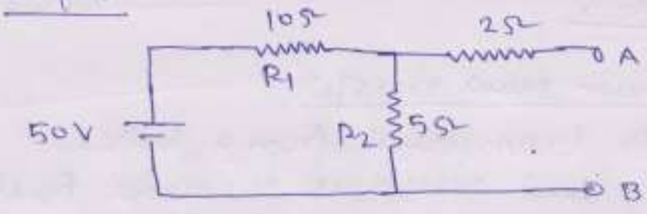
$$R_i = R_L$$



we have to calculate maximum power which is transferred to the load by source.

we can Approach this problem by applying thevenin Theorem to obtain thevenin Equivalent circuit with a single voltage source in series with a single resistance (R_{th}). then by making this R_{th} equal to the R_L, we can calculate maximum power which is transferred.

Step-1



$V_{Th} = V_{AB} = I R_2$

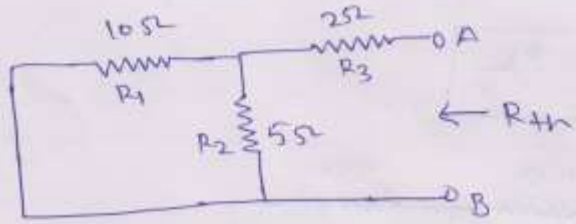
$$I = \frac{50\text{ volt}}{R_1 + R_2} = \frac{50V}{(10+5)\Omega} = \frac{50V}{15\Omega}$$

$\underline{I = 3.334\text{ A}}$

$V_{th} = 5 \times 3.334$

$\boxed{V_{th} = 16.670\text{ volt}}$

Step-2

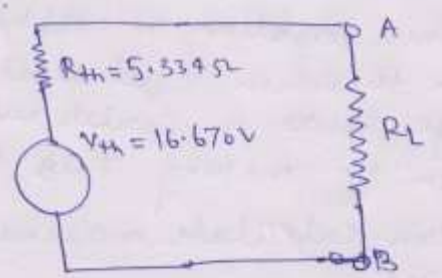


Thevenin resistance $(R_{th}) = (R_1 \parallel R_2) + R_3$

$$R_{th} = (10\Omega \parallel 5\Omega) + 2\Omega$$

$\boxed{R_{th} = 5.334\Omega}$

Step-3



When $R_{th} = R_L$ then maximum power will be transferred.

$$P = I^2 R_L$$

$$I = \frac{V_{th}}{R_{th} + R_L}$$

$$P = \frac{V_{th}^2}{(R_{th} + R_L)^2} \times R_L$$

$$R_{th} = R_L \Rightarrow P = P_{max}$$

$$P_{max} = \frac{V_{th}^2}{4 R_L^{\not{2}}} \cdot \not{R_L}$$

$$P_{max} = \frac{V_{th}^2}{4 \cdot R_L} = \frac{(16.670)^2}{4 \times 5.334} =$$

$$P_{max} = \frac{277.8889}{21.336}$$

$$\boxed{P_{max} = 13.02 \text{ watt}}$$

Answer 4

Total Number of Si atom in sample = 10×10^{27} atom/m^3

One Sb atom is doped out of 1×10^{10} atom of Si.

Sb behave as a donor in Si. Therefore.

Number of donor $(N_D) = \frac{10 \times 10^{27} \text{ atom}/m^3}{1 \times 10^{10}}$

$$N_D = 10 \times 10^{17} \text{ atom}/m^3$$

If the Semiconductor is kept at 300 K. Then This temperature is suffecient to ionized all the donor atom.

If all the donor atoms are ionized then

$N_D = n$ (number of majority carrier i.e. Electron)

$$n = 10 \times 10^{17} /m^3 = 10 \times 10^{17} \ m^{-3}$$

from Law of mass action.

$$n \cdot p = n_i^2$$

given that $n_i = 1.5 \times 10^{16} \ m^{-3}$

Therefore,

Number of hole's $(p) = \frac{n_i^2}{n}$

$$p = \frac{(1.5 \times 10^{16} \ m^{-3})^2}{10 \times 10^{17} \ m^{-3}}$$

$$p = \frac{2.25 \times 10^{32} \ m^{-6}}{10^{18} \ m^{-3}}$$

$$p = 2.25 \times 10^{12} \ m^{-3}$$

So,

Number of majority carrier at 300 K = $10^{18}\ m^{-3}$

Number of minority carrier at 300 K = $2.25 \times 10^{12}\ m^{-3}$

Answer - 5

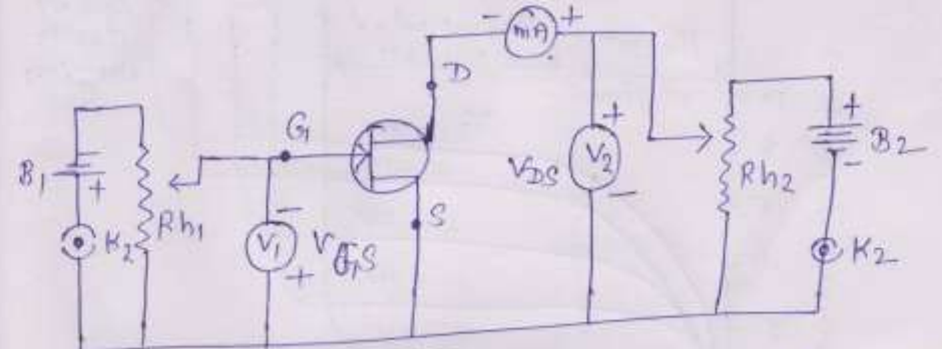


Fig: Circuit diagram of N-Channel J-FET

In this circuit battery B_1 is used as a potential divider with the help of a rheostat Rh_1 to apply a voltage V_{GS} between gate (G) and source (S), to keep the gate at reverse biased. Reverse gate source voltage can be read by voltmeter V_1.
Similarly battery B_2 is used as a potential divider by a rheostat Rh_2 to apply a voltage V_{DS} between the drain D and source S. The voltage V_{DS} is read by voltmeter V_2. The drain current (I_D) is read by milliammeter (mA)
By getting these values of voltage and current following two characteristics curves can be plotted for N-Channel J-FET.

(i) output characteristic curve.
(ii) Transfer characteristic curve.

(i) Output characteristic curve – Keeping the gate source voltage (V_{GS}) constant, a graph is plotted between the drain current I_D and drain source voltage

(VDS) which is called the output characteristics.

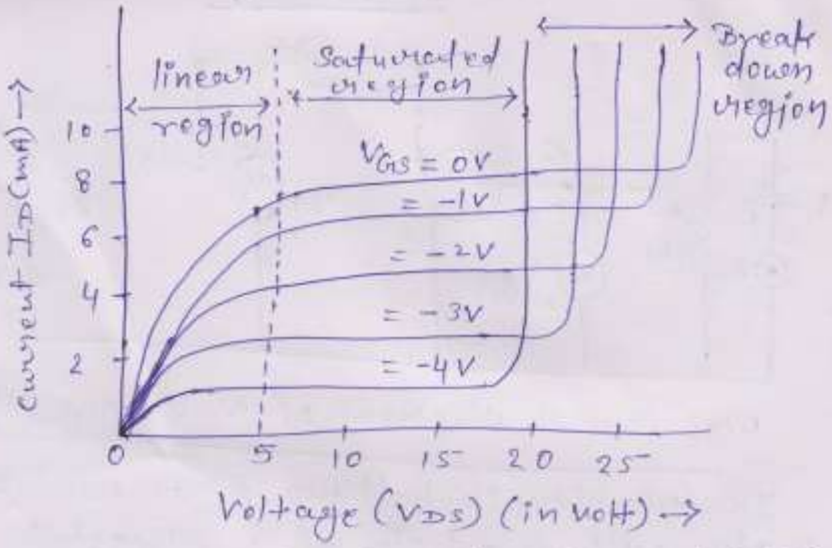


Fig:- Output characteristic of N-Channel J-FET

This characteristic have three different regions: ohmic or linear region, saturated region and breakdown region.

(a) Ohmic or linear region – when V_{DS} is very low, the drain current is directly proportional to the drain source voltage (i.e. $I_D \propto V_{DS}$). In this region the channel bar behaves like an ohmic conductor (or linear resistor).

(b) Saturated region – when the drain current I_D almost becomes constant and it does not depend on the drain source voltage V_{DS}.

when current begins to flow through the channel, there is a voltage drop along the length of the bar, due to which the gate-source junction gets more reverse biased. Hence the effective area of cross section of the channel decreases. with further increase in V_{DS} when $V_{DS} = V_P$, the drain current becomes saturated. In this condition the channel is called in pinched off condition and voltage V_p is called the pinched off voltage.

(c) Breakdown region – In this region, the drain current I_D increases abruptly with a small increase in drain source voltage V_{DS}. when V_{DS} is large then further increase in V_{DS}, at a particular value, the junction breakdown occurs and the drain current increases abruptly.

From the output characteristics it is clear that on increasing the reverse bias voltage between the gate and source, the breakdown voltage decreases.

(ii) Transfer characteristics –

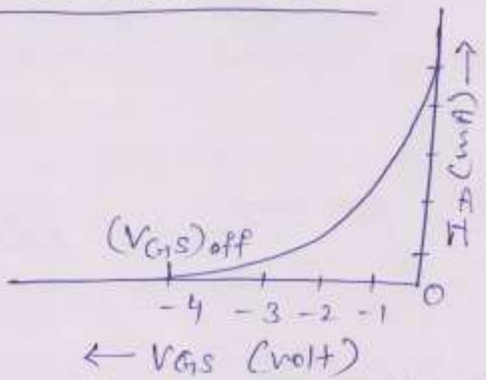


Fig: Transfer characteristics of N-channel J-FET

Transfer characteristics is plotted with the help of output characteristic curves. For different values of V_{GS}, the saturated drain current $(I_D)_{sat}$ is obtained from the output characteristic curves. Then a graph is plotted between $(I_D)_{sat}$ and V_{GS}, which is called the transfer characteristics. As the reverse bias voltage (V_{GS}) increases, the saturated drain current $(I_D)_{sat}$ decreases. The value of V_{GS} at which saturated drain current becomes zero, is called the gate source cutoff voltage $(V_{GS})_{off}$.

Ans. 6:- Given : $h_{iE} = 800\,\Omega$, $h_{fE} = 46$, $h_{oE} = 8\times10^{-5}\,ohm^{-1}$, $h_{rE} = 5.4\times10^{-4}$, $R_L = 5k\Omega = 5\times10^3\,\Omega$, $R_S = 500\,\Omega$

(i) Current gain $A_{iE} = \dfrac{h_{fE}}{1+h_{oE}R_L}$

$$= \frac{46}{1+(8\times10^{-5})(5\times10^3)} = 32.86$$

(ii) Input resistance $R_{iE} = h_{iE} - \dfrac{h_{rE}h_{fE}R_L}{1+h_{oE}R_L}$

$$= 800 - \frac{(5.4\times10^{-4})\times46\times5\times10^3}{1+(8\times10^{-5})(5\times10^3)}$$

$$= 800 - 88.7 = 711.3\,\Omega$$

(iii) Voltage gain $A_{vE} = \dfrac{-h_{fE}R_L}{h_{iE}+(h_{iE}h_{oE}-h_{rE}h_{fE})R_L}$

$$= \frac{-46\times5\times10^3}{800+(800\times8\times10^{-5}-5.4\times10^{-4}\times46)\times5\times10^3}$$

$$= \frac{-230\times10^3}{995.8} = -230.97$$

Answer - 7

d.c. load line:- It is the line on the output characteristics of a transistor circuit which gives the values of I_c and V_{CE} corresponding to zero signal or d.c. conditions.

Consider the transistor amplifier shown in fig. ①. In the absence of signal d.c. conditions prevail in the circuit as shown in figure 2.

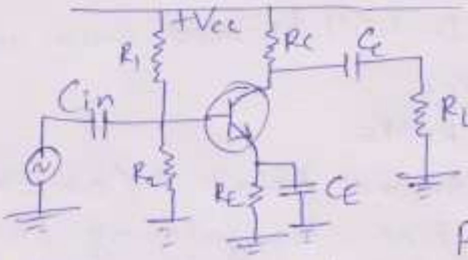


Figure 1.

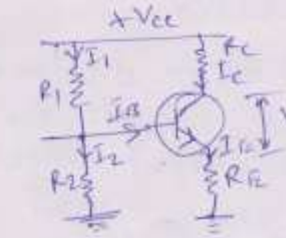


Figure 2 (i)

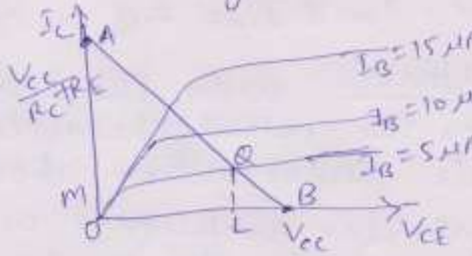


Figure 2(ii)

Referring to this circuit 2(i) and applying kirchoff's voltage law, $V_{CE} = V_{CC} - I_C R_C - I_E R_E$ ——— ①

$$V_{CE} = V_{CC} - I_C(R_C + R_E) \quad (\because I_E \simeq I_C)$$

This is called as load line equation.

As for a given circuit V_{CC} and $(R_C + R_E)$ are constant, therefore, it is a first degree equation and can be represented by a straight line on the output characteristics. This is known as d.c. load line and determines the locus of V_{CE} and I_C points in the zero signal conditions.

The d.c. load line can be readily plotted by ~~loading~~ + locating two end points of the straight line.

The value of V_{CE} will be maximum when $I_C = 0$. Therefore, by putting $I_C = 0$ in exp.

(i) we get, max $V_{CE} = V_{CC}$

This locates the first point B ($OB = V_{CC}$) of the d.c. load line.

The value of I_C will be maximum when $V_{CE} = 0$

$$\max.\ I_C = \frac{V_{CC}}{R_C + R_E}$$

This locates the second point A ($OA = V_{CC}/(R_C + R_E)$) of the d.c. load line. By joining points A and B, d.c. load line AB is constructed.

Importance:- With the construction of d.c. load line on the output characteristics, we get the complete information about the output circuit of transistor amplifier in the zero signal conditions. All the points showing zero signal I_C and V_{CE} will obviously lie on the d.c. load line.

Operating point:- At the same time I_C & V_{CE} conditions in the circuit are also represented by the point where d.c. load line intersects the base current curve under study. Thus referring to figure 2(ii), if $I_B = 5\mu A$ is set by the biasing circuit, then Q (i.e. intersection of $5\mu A$ curve and load line) is the operating point.

The zero signal values of I_C & V_{CE} are known as the operating points.

Answer - 8

Transformer coupled Amplifier :-

The main reason for low voltage and ~~the effective load (R~~ power gain of R-C coupled amplifier is that the effective load (R_{AC}) of each stage is decreased by due to the low resistance presented by the input of each stage to the preceding stage. If the effective load resistance of each stage could be increased, the voltage and power gain could be increased. This can be acheived by transformer coupling. By the use of impedance changing properties of transformer, the low resistance of a stage (or load) can be reflected as a high load resistance to the previous stage.

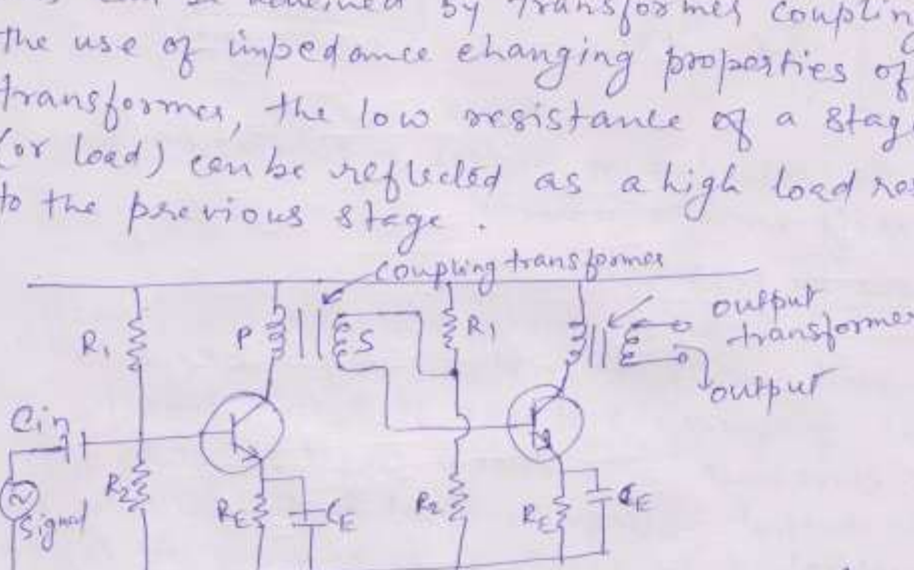


Figure. 1

Transformer Coupling is generally employed when the load is small. It is mostly used for power amplification. Figure 1. shows two stages of transformer coupled amplifier. A Coupling transformer is used to feed the output of one stage to the input of the next stage. The primary P of this transformer is made the collector load and its secondary S gives input to the next stage.

Operation:- when an a.c. signal is applied to the base of first transistor, it appears in the amplified form across primary P. of the Coupling transformer. The voltage developed across primary is transferred to the input of the next stage by the transformer secondary as shown in fig. 2.

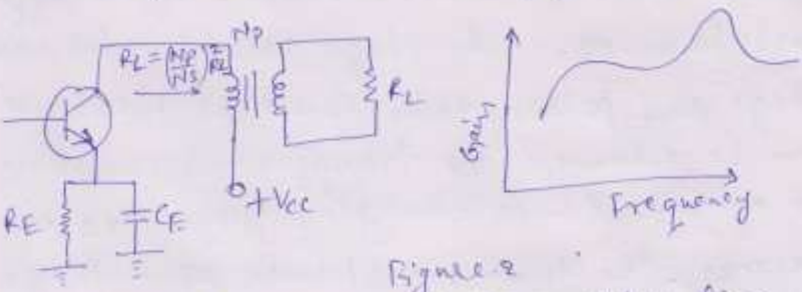


Figure 2

The second stage renders amplification in an exactly similar manner.

Frequency Response:-

The frequency response of a transformer coupled amplifier is shown in figure 2. It is clear that frequency response is rather poor i.e. gain is constant only over a small range of frequency. The output voltage is equal to the collector current multiplied by reactance of primary. At low frequencies, the reactance of primary begins to fall, resulting in decreased gain. At high frequencies, the capacitance between turns of winding acts as bypass condenser to reduce the output voltage and hence gain. It follows, therefore, that there will be disproportionate amplification of frequencies in a complete signal such as music, speech etc. Hence, transformer coupled amplifier introduces frequency distortion.

It many be added here that in a properly designed transformer, it is possible to acheive a fairly constant gain over the audio frequency range. But a transformer that achieves a frequency response comparable to R-C coupling may cost 10 to 20 times as much as the inexpensive RC coupled Amplifier.

Advantages:-

(i) No signal power is lost in the collector or base resistors.

(ii) An excellent impedance matching can be achieved in a transformer coupled amplifier. It is easy to make the inductive reactance of primary equal to the output impedance of the resistor and reactance of secondary equal to the input impodance of next stage.

(iii) Due to excellent impedance matching, transformer coupling provides higher gain. As a matter of fact, a ~~sign~~ single stage of properly designed transformer coupling can provide the gain of two stage's of RC coupling.

Disadvantages:-

i) It has a poor frequency response i.e. the gain varies considerably with frequency.

(ii) The coupling transformers are bulky and fairly expensive at audio frequencies.

(iii) Frequency distribution is higher i.e. low frequency signals are less amplified as compared to the high frequency signals.

(iv) Transformer coupling tends to introduce hum in the output.